motive force, within certain limits of error to be determined by a sub-committee appointed for the purpose of preparing a specification for the construction and use of the cell, is stated to be 1·433 volts at the temperature 62° F. By means of this cell and known resistances, it will be possible to calibrate instruments without the use of electrolysis, and this to many persons would be the readiest and most easily carried out method. Of course, logically speaking, the standard of electromotive force is settled when those of resistance and current are fixed, and thus, if the order of definition is adhered to, the cell does not come in. But its electromotive force having been determined by careful measurement, and found to be so constant as it is, and so consistently the same in different specimens when the mode of construction is carefully attended to, it is too valuable a standard of reference to be set aside.

A very interesting discussion took place as to the mode of preparing these cells, and on the experience of different investigators as to their behaviour. Some of the divergences stated in the discussion were probably due to the different degrees of manipulative skill possessed by the various observers. A few careful experiments with different batches of cells carried out personally by the members of the committee interested in the matter would set the question at rest, and probably entirely confirm Lord Rayleigh's marvellously consistent results.

A side-point which came out in discussion is worthy of notice. We have not in this country any legal definition of temperature, whether Centigrade or Fahrenheit. In the definition of the standard yard 62° Fahrenheit is specified, but there is nothing to tell how that temperature is to be determined. It is well known (though apparently not to some of the text-book writers on heat) that mercurial thermometers, made with different kinds of glass, while agreeing at the freezing and boiling points, agree nowhere else, and all differ more or less from the air-thermometer. In very accurate work these discrepancies become very important, and thermometers must be calibrated by means of standards, if their indications are to be of any use for comparison. Some legal definition of temperature will, ere long, have to be given, and it seems rather a pity that the Committee did not practically settle this by saying what they meant by 62° Fahrenheit.

The definition of the volt for alternating currents, embodied in Resolution 15, is, of course, a mere consequence of Resolution 11, and these two definitions taken together are specially applicable to the measurement of the power spent in lighting incandescent lamps.

We have only to note that the Committee, in Resolutions 12 and 16, adopted instruments on the principle of the balance for the measurement of currents, and on the principle of Sir William Thomson's quadrant electrometer, used idiostatically, for the measurement of differences of potential—except for large differences, when an electrometer on the principle of the balance is to be employed. Thus the beautiful electrometers invented long ago by Sir William Thomson are likely to become at last, in a modified form, Board of Trade standards of exact measurement in industrial electricity. This is by no means the only striking example which could be cited of the thoroughly practical, because thoroughly theoretical, character of the instruments invented by one who understands all sides of the difficult problem involved in the invention and construction of scientific apparatus.

No resolutions were framed by the Committee on the very important subject of the measurement of power and energy. This must, however, come to the front before very long, and will tax the resources of the standardizing laboratory and its officials, assisted, as no doubt they will be, by Committees such as this which has just reported. We congratulate the Committee on the results of its labours, and trust that the requisite Order in Council will be passed before long confirming its resolutions. The laboratory will then be able to get to work, the necessary standards which have been asked for so long will be made accessible to those engaged in the electrical industries, and some serious difficulties under which they have laboured, in supplying electric light and power to the public, will be at last removed.

THE CONGRESS OF HYGIENE.

WE print to-day a report of the important discussion in Section II. (Bacteriology) of the Congress of Hygiene, on "Immunity, Natural and Acquired":—

Dr. Roux, of the Institut Pasteur, in an introductory address, indicated the scope of the discussion. He began by saying that, in inviting a pupil of M. Pasteur to open the discussion on this subject, the Organizing Committee had reminded the Section that the great amount of interesting work which had recently been done on the subject had one point in common—namely, the attenuation of virus, and preventive inoculation, the two subjects with which M. Pasteur's name would for all time be honourably associated. With the single notable exception of vaccination, the only way of conferring immunity against any disease was the inoculation of the virus of the disease. To the old dangerous method of producing immunity by inoculation, Pasteur had added the less dangerous one of preventive inoculation by means of an attenuated virus, to which he had applied the term vaccination. The designation "attenuated" virus ought to be reserved for virus weakened without being attenuated—for example, by artificially lowering the vitality of the organisms for producing it.

Methods of Attenuation.—Two methods of attenuation had been described by M. Pasteur—namely, the prolonged exposure of a culture to air at a suitable temperature, and the passage of the micro-organisms through the bodies of different species of animals. Other methods had also been employed—for example, the action of heat, the use of antiseptics, of compressed oxygen and light.

In all cases, whatever the method employed, it was found to be necessary that the attenuation should be effected slowly and gradually; rapid attenuation rendered a virus altogether inactive without impressing on it any hereditary weakness. In whatever way the virus was prepared, it must, in order to confer immunity, be brought into direct contact with the tissues of the animal. In the early experiments the virus employed was always living; the living microbe, itself attenuated as to its virulence, was used. Another possible method of conferring immunity was the inoculation of the chemical substances produced by the micro-organisms.

Phagocytosis.—Dr. Roux next dealt with the doctrine of phagocytosis associated with the name of Dr. Metchnikoff. This observer had proved, by the study of the amœboid movement of certain cells that they possessed the power of including other cells and bodies in their substance. The phagocyte cells originated in the mesoderm. They possessed, further, the property of being able to digest the bodies which they had ingested. They were, in fact, the only cells which manifested in the human body any intracellular digestion. If the history of a bacterium in the interior of a phagocyte were followed, it would be seen that it underwent a peculiar series of alterations, very different from what took place when a microbe died in cultivating fluids. Whether a virulent virus was introduced into the bodies of animals which resisted inoculation, or whether attenuated microbes were injected into sensitive animals, the greater the degree of refractoriness shown by the animal, the more rapidly the microbes were consumed by the leucocytes. In a non-resistant animal the microbes remained free ; no such phenomenon as phagocytosis could be observed. It seemed, therefore, that the phagocytes were charged with the defence of the human organism, and entered into conflict with the parasites which infected the human frame. It might be said that there were diseases in which the microbes were to be met with in the cells specially, and that these microbes nevertheless proved fatal to the animal. In tuberculosis and in leprosy the bacilli were to be found in the cells, and the results were of the most serious kind, in spite of the intense phagocytosis induced by the microbes of these diseases. This fact proved that the phagocytes and all the other means of defence were, under certain conditions, and at certain times, powerless to effect any good results ; they had done their best to take up the microbes, but these had adapted themselves to the interior of the cells, and had conquered. It was not sufficient that the microbes should be eaten up, it was essential that they should also be digested by the phagocytes. Even in those cases where the struggle was going against the human organism, these cells still were the aggressors. It had been frequently observed in tuberculosis and leprosy that the bacilli had been killed in the interior of certain of these cells. The theory asserted that a struggle occurred between the microbes and the cells, but it did not imply that the bacilli always won the day. Phagocytosis only occurred in immune animals ; in animals susceptible to the disease it was either not to be observed, or it was incomplete.

He then proceeded to discuss the questions whether immunity was the consequence of this power of the cells to digest the virulent microbes. As had been said, the cells of a refractory animal took up the microbes, which, it would appear, under favourable circumstances remained inert in the interior of the cells.

Numerous facts had been alleged to show that the microbes at the time they were taken up by the phagocytes were not degenerated, but were, on the contrary, in a condition of full activity. Thus, to take only one example, it had been found that in frogs the bacilli which had been taken up by the lecocytes remained alive within the protoplasm of the cell ; this was apparent from their movements. In lymph taken from the body of a pigeon, numerous bacilli were to be seen imprisoned in the leucocytes, and these bacilli could be watched growing, actually under the eye of the observer, within the interior of dead phagocytes ; they could be seen to elongate, to push out the protoplasm, distort the form of the cell, and finally to make their escape. Another demonstration of the importance of the action of the phagocytes was afforded by the fact that even in immune animals the microbes were found to increase when kept out of the reach of the leucocytes ; thus, if a rabbit were inoculated in the anterior chamber of the eye, where there were no cells, the bacteria grew freely, and their development was only checked when the leucocytes had after a time migrated in large numbers, and began to take the microbes into their interior. It thus appeared that phagocytosis was a very general phenomenon, and one which was very efficacious in checking the advance of the organisms ; when it failed, the individual succumbed to the virulence of the bacteria. The question remained, What was the mysterious force which attracted the cells towards the microbes ? Why were the leucocytes, which in immune animals destroyed the microbes, incapable of seizing upon them in non-immune animals ?

In 1883, Metchnikoff propounded his theory of phagocytosis. This theory rested on two assumptions : first, that the cells were attracted to the microbes in virtue of a special sensibility manifested towards all foreign bodies introduced into the tissues ; the second was that this power of seizing upon the virulent microbes in immune animals originated in a habit formed during the earlier struggle with the attenuated virus with which the animal had been previously inoculated. The behaviour of the leucocytes might be more readily explained by assuming that leucocytes had the property, analogous to that possessed by the zoosperms of the myxomycetes—namely, that of being attracted by certain bodies and repelled by others. MM. Massart and Bordet had proved that the products of the microbes exerted a very marked chemical action on the phagocytes. When a virus was introduced into the body, it proliferated, and secreted a substance which attracted the leucocytes ; the more active the virus, the more energetic were the poisons elaborated by it, and the cells which penetrated to the point of inoculation were paralyzed in their action, and rendered incapable of taking up the microbes, which therefore proliferated without hindrance. Further, in certain diseases the virus produced a substance which was still more poisonous. In chicken cholera, for instance, the poison secreted by the microbes repelled the leucocytes from the point of inoculation ; it thus came about that phagocytes were never found in this particular affection. This, however, was not the case with animals which had been rendered immune either by inoculation of the attenuated virus, or by the injection of a suitable dose of bacterial products. If the animal were given a strong virus, phagocytes were attracted to the point of inoculation, and these possessed the power of taking up the microbes before they had time to elaborate effective doses of their toxic material. It was, therefore, at the commencement of the disease that the critical struggle took place. If the leucocytes could not accomplish this at the beginning of the malady, their action at a later period would be useless, since the microbes would have produced enough poison to paralyze their activity. Every cause, therefore, that prevented the access of leucocytes to the point of inoculation facilitated infection. The theory of immunity propounded by M. Metchnikoff did not exclude the possibility of there being other means of protecting the organism, but it simply proved that phagocytosis had a wider sphere of action, and was more efficacious, than any other means of protecting the organism. It seemed to explain all the facts, and was, moreover, eminently suggestive. It was in this way that the knowledge of microbic poisons and chemical inoculation had thrown light on what would otherwise have been obscure. Far from being shaken by the theories which were opposed to it, this theory of Metchnikoff's had gained by the opposition which it has met, and that was a guarantee of its soundness.

Dr. Buchner, of Munich, after giving a general account of the various theories of immunity, criticized freely Metchnikoff's views. The main objections he brought forward were as follows:—

(1) Many observers failed to notice any destruction of bacilli by phagocytes, when naturally immune animals, such as white rats or pigeons, were inoculated with anthrax.

(2) In diseases ending fatally, such as tuberculosis, mice-septicæmia, &c., the micro-organisms were frequently found in the interior of phagocytes.

(3) The experiments of Petruchky, Baumgarten, Pekelharing, and others seemed to show that the bacilli of anthrax perished in the living fluids of immune animals even when the bacilli were protected against the attacks of white corpuscles.

Metchnikoff, however, denied this, and proved that the living fluids of immune white rats form a most excellent cultivating medium for the bacilli of anthrax. These observations of Metchnikoff, according to Buchner, might be explained by the fact that Metchnikoff in his experiments introduced more bacilli than could be destroyed by the living fluids of white rats, as a certain quantity of serum was able to destroy only a very small quantity of micro-organisms. Speaking of the experiments made by his pupils Ibener and Roeder, he stated that, when a certain kind of micro-organisms were placed into a given quantity of serum, the micro-organisms might either be destroyed *in toto*, or reproduce themselves in large numbers according to the number of micro-organisms introduced in the first place into the serum. When, instead of placing the micro-organisms directly in contact with the serum, the micro-organisms were wrapped up in sterilised cotton-wool, it was found that the bacilli, so protected against the temporary harmful influence of serum, began to grow luxuriantly at the end of twenty-four hours. The bactericidal power of serum disappeared, therefore, shortly after death.

Massart, Bordet, and Gabritchewsky had previously proved that the emigration of leucocytes to the spot where the virus was introduced was due to the attracting influence (positive chemotaxis) of the chemical poisons secreted by micro-organisms, but he (Buchner) was of opinion that the substances dissolved in the cultures have hardly any action on leucocytes, but that this attracting influence on leucocytes was due to the protein present in bacterial cells themselves. Whereas the products of the metabolism of micro-organisms had little or no attracting influence on the leucocytes, the proteins themselves attracted the cells most powerfully.

As long as the bacterial cells were active and capable of reproducing themselves actively, the proteins were contained in the cells, and these poisons only left the cells when the latter became diseased or old. Hence these proteins were chiefly found in old cultures, the filtered and sterilised extracts of which always possessed a strong attracting influence on leucocytes. Hence it followed that, "The more a given micro-organism is harmfully influenced by the living fluids of a given species of animals, the more proteins will be excreted. This, as a natural consequence, is followed by a corresponding increase in the number of cells which emigrate to the point of inoculation." In every case the living fluids of the body exert a harmful influence on micro-organisms, and then, when in consequence of this the excretion of proteins takes place, the amœboid cells emigrate to the spot.

Turning now to the characteristics of this germicidal substance present in serum, he thought that this germicidal power gradually disappeared, so that after a few days the serum had no bactericidal power. This germicidal action was destroyed by the micro-organisms themselves, for, unless the latter were completely destroyed, they soon began to grow freely in serum. This germicidal substance was easily destroyed by heat. Serum which had been maintained at 55° C. during half an hour, or at 52° C. during six hours, lost its bactericidal power completely. A moderate degree of warmth (37° C.) intensified the germicidal action of the blood or serum.

Turning now to the question as to whether this bactericidal action of the blood had any share in the production of immunity, he gave the following facts as proving that there was some connection between the immunity of a given animal against a given infectious disease, and the bactericidal action of its blood on the micro-organism producing the disease:—

(*a*) The blood and serum of animals, such as mice and guinea-pigs, which readily succumbed to anthrax had no bactericidal power on anthrax-bacilli.

(*b*) The serum of animals which took anthrax readily never possessed such a strong bactericidal action as the serum of white rats, which were immune against anthrax.

(*c*) The blood and serum of animals rendered artificially immune possessed stronger bactericidal powers than the blood and serum of normal animals.

(*d*) The blood and serum of animals rendered artificially immune against a given micro-organism lessened the virulence of the specific micro-organism causing the disease.

(*e*) Whenever blood and serum possessed no bactericidal action on micro-organisms, this absence of bactericidal action might be due to the fact that, owing to the necessary manipulations, this bactericidal substance had been altered or even destroyed.

As further proving that the immunity of animals depended on some substance present in the serum, he mentioned the facts described by Behring, Kitasato, Ogata, and Emmerich, in which the injection of blood or serum of an animal immune against a given bacillus, cured another animal afflicted with the same disease. This curative power he attributed to the presence in the blood of immune animals of a protective substance, probably proteid in its nature, to which he gave the name of "alexine" (from ἀλεξεῖν, to protect). These alexines were not ordinary oxidation products of the tissues, as they were quite specific in their action. They were not simply enzymes, as they had no hydrolytic properties, but they were most probably proteid substances. These alexines were probably formed in the cells; but, when formed, their action was quite independent from that of cells, and they were probably always present in immune animals.

Mr. E. H. Hankin, of Cambridge, after giving a *résumé* of the work done by various observers, said that theoretical considerations led him to suspect that a particular ferment-like proteid, known as cell globulin B, was a substance possessing bactericidal power. He tested its action on anthrax bacilli, and found that it had the power of destroying these microbes.

He further found that similar substances were present, not only in animals that were naturally immune against anthrax, but also in those that were susceptible to this disease. To these substances he had given the name of *defensive proteids*. In his published papers on this subject he had noted various similarities in the bactericidal action of these substances, and that possessed by blood-serum, and these resemblances were such as to leave little room for doubt that the bactericidal action of blood-serum was due to the presence of these defensive proteids.

The serum of white rats contained a proteid body possessing a well-marked alkaline reaction, and a power of destroying anthrax bacilli. Further, when injected into mice along with fully virulent anthrax spores, it would prevent the development of the disease. On the other hand, defensive proteids of animals susceptible to anthrax did not exert such protective power, and consequently these experiments indicated a difference in the mode of action of defensive proteids of immune and non-immune animals respectively. Further, the amount of defensive proteid present in a rat could be diminished by the causes which were known to be capable of lowering the animal's power of resisting anthrax. For instance, Feser stated that rats become susceptible to anthrax when fed on a vegetarian diet. Mr. Hankin obtained similar results with wild rats. The ordinary white rat he found to be generally refractory to anthrax on any diet, and the defensive proteid could always be obtained from its spleen and blood-serum. This was not the case with wild rats. In one experiment eight wild rats were used; of these, four were fed on bread and meat, the others on plain bread, for about six weeks. Then one rat of each lot was inoculated with anthrax; of these, the one that had been subjected to a bread diet succumbed. The remaining rats were killed, and it was found that while the spleens of the flesh-fed rats contained abundance of the defensive proteid, only traces of this substance could be obtained from the spleens of the rats that had been fed on bread alone. A similar result was obtained in other experiments.

Very young rats were known to be susceptible to anthrax, and so far as could be judged from the litmus test (after dialysis and addition of NaCl), their serum appeared to contain less of the defensive proteid than did that of the adult rat. Further, Mr. Hankin found that a young rat could be preserved from anthrax by an injection of its parent's blood-serum.

These facts appeared to prove that the defensive proteid of the rat deserved its name, in that it preserves the animal from the attack of the anthrax microbe; in other words, that this substance was at any rate a part cause of the rat's immunity against anthrax.

Defensive proteids appeared to be ferment like, albuminous bodies, and it was extremely unlikely that we should for a considerable time be able to classify them by any other than physiological tests. From this point of view it was possible to divide them into two classes; first, those occurring naturally in normal animals, and secondly, those occurring in animals that have artificially been made immune. For these two classes Mr. Hankin proposed the names of *sozins* and *phylaxins*. A "sozin" was a defensive proteid that occurred naturally in a normal animal. They had been found in all animals yet examined, and appear to act on numerous kinds of microbes or on their products. A "phylaxin" was a defensive proteid which was only found in an animal that had been artificially made immune against a disease, and which (so far as is yet known) only acted on one kind of microbe or on its products.

Each of these classes of defensive proteids could obviously be further subdivided into those that acted on the microbe itself, and those that acted on the poisons it generated. These subclasses he proposed to denote by adding the prefixes myco- and toxo- to the class name. Thus myco-sozins were defensive proteids occurring in the normal animal, which had the power of acting on various species of microbe. Toxo-sozins were defensive proteids, also occurring in the normal animal, having the power of destroying poisons produced by various microbes. Myco-phylaxins and toxo-phylaxins similarly would denote the two sub-classes of the phylaxin group.

The classification might be represented by the following scheme:—

Defensive proteids (Hankin). Alexins (Buchner).	Sozins:— Defensive proteids present in the normal animal.	Myco-sozins:— Alkaline globulins from rat (Hankin), destroying anthrax bacillus.
		Toxo-sozins:— Of rabbit, destroying *V. metchnikovi* poison (Gamaleia).
	Phylaxins:— Defensive proteids present in the animal after it has been made artificially immune.	Myco-phylaxins:— Of rabbit, destroying pig typhoid bacillus (Emmerich).
		Toxo-phylaxins;— Of rabbit, &c., destroying diphtheria and tetanus poisons (Behring and Kitasato, antitoxin of Tizzoni and Cattani).

Prof. Emmerich, of Munich, read a paper on "The Artificial Production of Immunity against Croupous Pneumonia and the

Cure of this Disease." He stated that his previous experiments on swine fever had proved that in immune animals the bacilli of swine fever were destroyed, not by the cells of the animal, but by a bactericidal substance present in the blood. It had been clearly proved by his experiments that the bacilli of swine fever were destroyed almost immediately after their introduction under an immune animal's skin. Applying these researches to the disease produced in rabbits by the inoculation of the *Diplococcus pneumoniæ* of Fraenkel, he showed that non-immune rabbits died within twenty-four to forty-eight hours after the introduction of the virus. But if such animals had been previously treated with the blood or serum of animals rendered artificially immune against the diplococcus of Fraenkel, such animals did not die, but recovered after the introduction of extremely virulent diplococci. Moreover, when the *Diplococcus pneumoniæ* was inoculated into an animal, it was possible to cure it by injecting shortly afterwards some of the serum of an animal rendered artificially immune. In the blood of animals rendered artificially immune against pneumonia we possessed an excellent cure for the disease. Not only would it be possible to cure men afflicted with pneumonia by these injections, but we could, by preventive inoculations applied in time, put a stop to the spread of an epidemic in a school or a prison for instance. His experiments, together with Dr. Doenissen's, had a great practical as well as a theoretical value.

Dr. Ehrlich, of Berlin, stated that he had lately made a number of experiments with ricin which threw great light on the question of immunity. According to Kobert and Stillmark, ricin was an extremely poisonous body, for it acted fatally when such small doses as 0·03 mg. were injected into an animal's veins. When absorbed through the alimentary canal, a dose 100 times larger could be easily tolerated. Nevertheless, even then, it was so toxic that, according to Kobert's reckoning, a dose of 0·18 gr. would prove fatal to a full-grown man. It had a harmful influence on the blood, producing coagulation of the red blood-corpuscles, and thromboses, more especially of the vessels of the alimentary canal.

In his opinion the toxicity of ricin greatly depended on the species of animals used for experiments, the animals most susceptible to its action being guinea-pigs. Thus, a guinea-pig weighing 385 grammes died eleven days after the inoculation of 0·7 cc. of a 1 in 150,000 solution of ricin, the *post-mortem* examination showing characteristic hæmorrhages in the alimentary tract. One gramme of this substance might therefore prove fatal to 1,500,000 guinea-pigs. White mice, on the other hand, did not die after much larger doses, and this immunity of mice against this poison might be increased by subcutaneous injections of ricin. The same result might be obtained, however, far more easily and without any chances of failure, by feeding mice with ricin. It was best to begin with small, harmless doses, gradually increasing the amount until the organism was accustomed to the poisonous substance. In ten days a mouse might then be inoculated with a deadly or even larger dose without suffering any evil effects. Thus, whilst doses of 1/200000 gramme was absolutely fatal in normal animals, mice fed daily and in increasing quantities with ricin suffered no harm after the injection of 1/1000 gr. or 1/500 gr., or, occasionally, of 1/250 gr.

Whilst a 0·5 or 1 per cent. solution of ricin applied to the eye of a normal animal produced severe inflammation and panophthalmitis, the application of a 10 per cent. solution of ricin produced no effect on the eye of an animal previously fed with ricin. In other words, this was distinct proof of the existence of a local as well as of a general immunity against the poison. Strangely enough it was almost impossible to render the subcutaneous tissue immune against ricin, and even in exceedingly immune animals the subcutaneous injection of ricin produced distinct necrosis of the subcutaneous tissue.

It was a remarkable fact that this immunity appeared quite suddenly on the sixth day, and then increased slowly, so that on the twenty-first day the animal could stand a dose which was 400 times higher than that fatal to a normal animal.

This immunity against ricin appeared to be permanent, for it was still present in immune mice which had not taken ricin for a period of six months previously.

He had been able to extract from the blood of animals rendered immune against ricin a body which had the power of counteracting the toxic action of ricin, so that a powerful solution of ricin was rendered harmless by admixture with the blood of immune mice. It was also possible to render animals immune against ricin by injecting the blood of immune animals.

He had obtained similar results with abrin, which would be shortly published.

Dr. Kitasato, of Tokio, shortly summarized the results which he and Dr. Behring had obtained with the virus of tetanus. According to these observers, the blood of a normal rabbit has no influence on the toxines secreted by the bacillus of tetanus. But when a rabbit had been rendered artificially immune against that disease, its blood had the power of destroying the toxines secreted by the specific bacillus. Nay, more, the blood of rabbits made artificially immune against tetanus with trichloride of iodine, rendered mice not only refractory to tetanus but also cured the disease when already in progress. The blood, however, did not appear to act on the tetanus bacillus itself, but on the toxines secreted by the bacillus.

Dr. Adami, of Cambridge, thought that it was impossible to doubt that in a large number of infectious diseases the process of phagocytosis was extremely marked. He was of opinion that it was quite possible to accept both views of the question. The controversy had taken place chiefly as to the phenomena observed in the rat; in that animal phagocytosis was only to be observed with difficulty, and the serum of rat's blood undoubtedly possessed bacteria-killing properties to a high degree.

Dr. Klein, of London, stated that frogs and rats were insusceptible to anthrax, but that these animals could be made susceptible to the disease by a variety of means, indicating that their normal power of resistance was due to certain chemical conditions of the blood. If the bacillus of anthrax was introduced into the lymph-sac of a chloroformed frog, this animal always died of anthrax. Rats inoculated with anthrax and kept under the influence of an anæsthetic also died of anthrax. He had been unable to find any evidence to show that in these cases the leucocytes had lost their power of swallowing up bacteria, and therefore the susceptibility of chloroformed animals to anthrax could only be explained by some chemical changes taking place in the serum of the chloroformed rat or frog.

Dr. Metchnikoff, of Paris, who was greeted with loud and prolonged cheering, said that, of all the objections which have been raised against the theory of phagocytes, doubtless by far the most important was that formulated by Behring and Nissen: namely, the fact that the serum of guinea-pigs vaccinated against the vibrio of Metchnikoff had bactericidal powers on the same vibrio. Whilst the serum of normal guinea-pigs allowed the free development of a large number of these microbes, the serum of vaccinated animals killed the micro-organisms at the end of a few hours. MM. Behring and Nissen were convinced that this fact formed a complete explanation of the acquired immunity of guinea-pigs against the *Vibrio Metchnikofi*, and that it might serve as a model for a theory of immunity. His own researches, however, proved the contrary. If one studied the phenomena as they occurred in the living animal, one noticed at once that the bacilli inoculated into immune guinea-pigs remained alive for a very long time. Some vibrios were taken into the interior of leucocytes at the point of inoculation, whilst others developed perfectly in the liquid exudation. To show this, one had only to take a drop of the latter, and place it in the warm chamber; the leucocytes perished when taken out of the organism, and allowed the bacilli contained in their interior to develop freely. The vibrions thus multiplied and filled the leucocytes, which swelled and eventually burst, allowing the microbes to pass freely into the liquid part of the exudation. Here the development continued, and one obtained very abundant cultures from the liquid exudation of the immune guinea-pig. If one extracted a small quantity of such a culture, and introduced it into the dead serum of an immune guinea-pig, this serum not only did not kill the bacilli, but also gave a more abundant development than the serum of a non-immune animal could do. The study of the phenomena in living animals made artificially immune against the vibrio of Metchnikoff, instead of overthrowing the theory of phagocytosis, furnished on the contrary an evident proof in its favour. The theories of the attenuation of virus in the bodies of immune animals, and of the neutralization of the toxines, could not be applied to his case, as the vibrios remained very virulent, and because the immune guinea-pigs are as sensitive to the toxine of the bacillus as the non-immune animal.

This example showed yet once more that one must not be content with studying the phenomena of immunity outside the organism. This criticism also applied to M. Buchner's experiments, which he had communicated to this meeting; he insisted on the fact that, in order to assure one's self thoroughly of the bactericidal property of the serum, it was necessary to take a small quantity of the culture, and spread it in a tube filled with serum. If, according to Dr. Buchner, one introduced a little of the culture wrapped in cotton-wool, the serum could no longer exercise its bactericidal power, and the microbe developed freely. Now, when one inoculated the bacillus under the skin of an animal, one introduced at the same time a small mass which did not spread freely in the blood or exudation, but remained localized at one spot. The experiments of Mr. Buchner, instead of furnishing an objection to the phagocyte theory, rather supported it.

Referring to the curative properties of the serum of white rats against anthrax, he had come to the conclusion that, whereas the living serum of white rats had no bactericidal action on anthrax, the dead serum of the same animals had marked bactericidal powers on the same micro-organism. When a mouse was inoculated with a mixture of the dead serum of a rat and anthrax bacilli, it nearly always died, although the disease lasted somewhat longer than usual. On examination of the point of inoculation it was found that the bacilli of anthrax did not grow quite so readily, and that an enormous number of leucocytes emigrated to the point of inoculation and took the bacilli into their interior and digested them. In tetanus, again, the leucocytes ate up considerable quantities of tetanus-spores and bacilli. Summing up his researches, he stated that whenever an animal recovered from an infectious disease this recovery was accompanied by a process of phagocytosis; whenever an animal died of an infectious disease the process of phagocytosis was absent or insufficient. The theory of phagocytes was strictly based on the principles of evolution as laid down by Darwin and Wallace.

After some remarks by Dr. Fodor, Dr. Cartwright Wood, Prof. Babes, Dr. Wright, and Dr. Arloing,

Dr. Roux, answering some remarks made by Prof. Emmerich, stated that, far from the preventive inoculations against anthrax and swine fever having been proved to be unsuccessful, agriculturists in France and other countries were making use of them daily, and the use of the various vaccins manufactured at the Institut Pasteur was increasing day by day.

Dr. Buchner congratulated Dr. Metchnikoff on his most important paper. He was of opinion, however, that the time for framing a complete theory of immunity had not come yet.

Sir Joseph Lister then stated that if anything were required to justify the existence of this Congress it would have been their sitting that day. The immense amount of valuable material which they had had on this most important subject had been such as to make all the members exceedingly grateful to those who had brought these matters before them.

THE BRITISH ASSOCIATION.

THE following is a list of the grants of money appropriated to scientific purposes by the General Committee at the Cardiff meeting, August 1891. The names of the members entitled to call on the General Treasurer for the respective grants are prefixed:

A.—*Mathematics and Physics.*

	£	s.	d.
*Foster, Prof. Carey—Electrical Standards (partly renewed)	27	4	6
*McLaren, Lord—Meteorological Observations on Ben Nevis	50	0	0
*Symons, Mr. G. J.—Photographs of Meteorological Phenomena	15	0	0
*Cayley, Prof.—Pellian Equation Tables (partly renewed)	15	0	0
*Rayleigh, Lord—Tables of Mathematical Functions	15	0	0
*Fitzgerald, Prof. G. F.—Electrolysis	5	0	0
*Lodge, Prof.—Discharge of Electricity from Points	50	0	0
*Thomson, Sir W.—Seismological Phenomena of Japan	10	0	0
B.—*Chemistry and Mineralogy.*			
*Roberts-Austen, Prof.—Analysis of Iron and Steel (renewed)	8	16	0
*Armstrong, Prof. H. E.—Formation of Haloids from Pure Materials (partly renewed)	25	5	0
*Tilden, Prof. W. A.—Properties of Solutions ...	10	0	0
*Thorpe, Prof.—Action of Light upon Dyed Colours (partly renewed)	10	0	0
C.—*Geology.*			
*Prestwich, Prof.—Erratic Blocks (partly renewed)	15	0	0
*Wiltshire, Rev. T.—Fossil Phyllopoda (renewed)	10	0	0
*Geikie, Prof. J.—Photographs of Geological Interest	20	0	0
*Woodward, Dr. H.—Registration of Type Specimens of British Fossils (renewed)	5	0	0
*Hull, Prof. E.—Underground Waters	10	0	0
*Davis, Mr. J. W.—Investigation of Elbolton Cave	25	0	0
Jones, Prof. R.—Faunal Contents of *Sowerbyi* Zone	10	0	0
*Evans, Dr. J.—Excavations at Oldbury Hill ...	25	0	0
*Woodward, Dr. H.—Cretaceous Polyzoa... ...	10	0	0
D.—*Biology.*			
*Sclater, Dr. P. L.—Table at the Naples Zoological Station	100	0	0
*Lankester, Mr. E. R.—Table at Plymouth Biological Laboratory (renewed)	17	10	0
*Haddon, Prof. A. C.—Improving a Deep-sea Tow-net (partly renewed)	40	0	0
*Newton, Prof.—Fauna of Sandwich Islands (renewed)	100	0	0
*Sclater, Dr. P. L.—Zoology and Botany of the West India Islands (renewed)	100	0	0
E.—*Geography.*			
Ravenstein, Mr. E. G.—Climatology and Hydrography of Tropical Africa	75	0	0
H.—*Anthropology.*			
*Flower, Prof.—Anthropometric Laboratory ...	5	0	0
Garson, Dr. J. G.—Prehistoric Remains in Mashonaland	50	0	0
*Tylor, Dr. E. B.—North-western Tribes of Canada	100	0	0
*Turner, Sir W.—Habits, Customs, &c., of Natives of India (renewed)	10	0	0
*Flower, Prof.—New Edition of Anthropological Notes and Queries	20	0	0
*Symons, Mr. G. J.—Corresponding Societies' Committee...	25	0	0
	£1013	15	6

* Reappointed.

SECTION E.

GEOGRAPHY.

OPENING ADDRESS BY E. G. RAVENSTEIN, F.R.G.S., F.S.S., PRESIDENT OF THE SECTION.

The Field of Geography.[1]

IT behoves every man from time to time to survey the field of his labours, and to render an account unto himself of the work he has accomplished, and of the tasks which still await him, in order that he may perceive whether the means employed hitherto are commensurate with the magnitude of his undertaking, and likely to lead up to the desired results. Such a survey of the "Field of Geography" I propose to make the subject of my address to-day. . . .

Whatever changes may have taken place respecting the aims of the geographer, it is very generally acknowledged that the portraiture of the earth's surface in the shape of a map lies within his proper and immediate domain. And there can be no doubt that a map possesses unique facilities for recording the fundamental facts of geographical knowledge, and that with a

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[1] Pressure on our space compels us to omit some parts of this address.